Absolute Equation of State Measurements of Shocked Liquid Deuterium up to 200 GPa (2 Mbar) [1]

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Abstract

We present results of the first measurements of density, shock speed and particle speed in compressed liquid deuterium compressed at pressures in excess of 1 Mbar.[2] High intensity lasers offer the opportunity to explore the equations of state (EOS) of materials at high compressions. Experimentally verified equations of state do not exist for many materials in the multimbar regime due to the inherent difficulties of achieving such high pressures. While high intensity lasers can readily produce shocks in this pressure regime, the requirements for an accurate EOS measurement are formidable. Thus, there have been few laser-driven EOS experiments despite the fact that the EOS is crucial for hydrodynamic descriptions of laser experiments. Accuracy sufficient to differentiate between various EOS models is difficult to obtain for many reasons. The initial condition of the sample may be difficult to determine due to preheat. The shock may not be spatially uniform and planar or its velocity may not be steady in time.

We have performed EOS measurements on the principal Hugoniot of liquid deuterium from .2 to 2 Mbar. We employ high-resolution radiography to simultaneously measure the shock and particle speeds in the deuterium, as well as to directly measure the compression of the sample. We are also attempting to measure the color temperature of the shocked D_2. Key to this effort is the development and implementation of interferometric methods in order to carefully characterize the shock profile and steadiness and the level of preheat in the samples. These experiments allow us to differentiate between the accepted EOS model for D_2 and a new model which includes the effects of molecular dissociation on the EOS.[3]

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[2] L. B. Da Silva *et al.*, *Phys. Rev. Lett* in press (1996).

[3] N. C. Holmes, M. Ross, and W. J. Nellis, *Phys. Rev. B* **52**, 15835 (1995).